WHAT IS CLAIMED IS

1. A direct conversion receiver comprising:

a poly-phase filter that generates an in-phase differential signal and a quadrature-phase differential signal derived from a received radio frequency (RF) signal;

an in-phase mixer which mixes the in-phase differential signal with a first local oscillation signal and a second local oscillation signal;

a quadrature-phase mixer which mixes the quadrature-phase differential signal with the first local oscillation signal and a third local oscillation signal; and

a mismatch estimation unit that estimates the phase mismatch of the poly-phase filter, or a phase mismatch of the in-phase mixer and the quadrature-phase mixer, from output signals of the in-phase mixer and the quadrature-phase mixer, for adjusting at least one of the phase mismatch of the poly-phase filter and the phase mismatch of the in-phase mixer and the quadrature-phase mixer, in response to an output signal of the mismatch estimation unit.

2. The direct conversion receiver of claim 1, wherein the phase mismatch of the in-phase mixer and the quadrature-phase mixer varies in response to the output signal of the mismatch estimation unit.

3. The direct conversion receiver of claim 2, wherein

the in-phase mixer comprises a first mixer which mixes the in-phase differential signal with the first local oscillation signal, and a second mixer which mixes the in-phase differential signal with the second local oscillation signal; and

the quadrature-phase mixer comprises a third mixer which mixes the quadrature-phase differential signal with the first local oscillation signal, and a fourth mixer which mixes the quadrature-phase differential signal with the third local oscillation signal, and the second local oscillation signal and the first local oscillation signal have a phase difference of 90° plus a first variable phase calibration factor, and the third local oscillation signal and the first local oscillation

signal have a phase difference of 90° plus a second variable phase calibration factor.

4. The direct conversion receiver of claim 3, wherein the first variable phase calibration factor and the second variable phase calibration factor have opposite signs and the same absolute value.

5. The direct conversion receiver of claim 3, wherein

the in-phase mixer further comprises a 90° phase shifter, that phase shifts the first local oscillation signal and outputs a signal, and a first variable phase shifter for shifting the output signal of the 90° phase shifter by the first variable phase calibration factor and generates the second local oscillation signal; and

the quadrature-phase mixer further comprises a second variable phase shifter for shifting the output signal of the 90° phase shifter by the second variable phase calibration factor and thereby generates the third local oscillation signal.

6. The direct conversion receiver of claim 3, further comprising:

a subtracter that subtracts an output signal of the fourth mixer from an output signal of the first mixer and generates an I-path signal;

an adder that adds an output signal of the second mixer and an output signal of the third mixer and generates a Q-path signal; and

wherein the mismatch estimation unit outputs a mismatch signal that is a result of adding a signal obtained by squaring the I-path signal and a signal obtained by squaring the Q-path signal.

7. The direct conversion receiver of claim 6, wherein the mismatch estimation unit comprises:

a first square unit which squares the I-path signal;

a second square unit which squares the Q-path signal; and

a mismatch estimation unit adder that adds the output signals of the first and second square units.

8. The direct conversion receiver of claim 6, wherein at least one of the first variable phase calibration factor and the second variable phase calibration factor varies in response to the signal output from the mismatch estimation unit.

9. A direct conversion receiver (DCR) comprising:

a poly-phase filter which receives a differential signal and generates an in-phase differential signal and a quadrature-phase differential signal derived from a received radio frequency (RF) signal;

an in-phase mixer that mixes the in-phase differential signal with a first local oscillation signal and a second local oscillation signal;

a quadrature-phase mixer that mixes the quadrature-phase differential signal with the first local oscillation signal and the second oscillation signal; and

a mismatch estimation unit that estimates a DCR gain mismatch, including a gain mismatch of the poly-phase filter or a gain mismatch of the in-phase mixer and the quadrature-phase mixer, from the output signals of the in-phase mixer and of the quadrature-phase mixer, for adjusting the gain mismatch of the poly-phase filter, or the gain mismatch of the in-phase mixer and the quadrature-phase mixer, in response to an output signal of the mismatch estimation unit.

10. The direct conversion receiver of claim 9, wherein the gain mismatch of the in-phase mixer and the quadrature-phase mixer varies in response to the output signal of the mismatch estimation unit.

11. The direct conversion receiver of claim 10, wherein

the in-phase mixer comprises a first mixer that mixes the in-phase differential signal with the first local oscillation signal, and a second mixer that mixes the in-phase differential signal with the second local oscillation signal, the second local oscillation signal and the first local oscillation signal having a phase difference of approximately 90°; and

the quadrature-phase mixer comprises a third mixer, that mixes the quadrature-phase differential signal with the first local oscillation signal, and a fourth mixer, that mixes the quadrature-phase differential signal with the second local oscillation signal.

12. The direct conversion receiver of claim 11, wherein the in-phase mixer further comprises a variable gain adjuster for adjusting the gain of input signals or output signals of the first mixer and the second mixer.

13. The direct conversion receiver of claim 11, wherein the quadrature-phase mixer further comprises a variable gain adjuster for adjusting the gain of input signals or output signals of the third mixer and the fourth mixer.

14. The direct conversion receiver of claim 13, further comprising:

a subtracter that subtracts an output signal of the fourth mixer from an output signal of the first mixer, and generates an I-path signal;

an adder that adds an output signal of the second mixer and an output signal of the third mixer, and generates a Q-path signal; and

wherein the mismatch estimation unit outputs a signal that is a result of adding a signal obtained by squaring the I-path signal and a signal obtained by squaring the Q-path signal.

15. The direct conversion receiver of claim 9, wherein the gain mismatch of the poly-phase filter is calibrated for in response to an output signal of the mismatch estimation unit.

16. A direct conversion receiver (DCR) comprising:

a poly-phase filter that generates an in-phase differential signal and a quadrature-phase differential signal derived from a received radio frequency (RF) signal;

a differential signal adder that adds the in-phase differential signal and the quadrature-phase differential signal, and generates an added differential signal;

a differential signal subtracter that subtracts the quadrature-phase differential signal from the in-phase differential signal, and generates a subtracted differential signal;

a mixer unit that mixes the added differential signal with a first local oscillation signal and mixes the subtracted differential signal with a second local oscillation signal; and

a mismatch estimation unit for estimating a DCR phase mismatch from signals output from the mixer unit, for adjusting the phase mismatch of the poly-phase filter or the phase mismatch of the mixer unit in response to an output signal of the mismatch estimation unit.

17. The direct conversion receiver of claim 16, wherein the mixer unit comprises:

a first mixer that mixes the added differential signal with the first local oscillation signal; and

a second mixer that mixes the subtracted differential signal with the second local oscillation signal.

18. The direct conversion receiver of claim 17, wherein the phase of the second local oscillation signal and the first local oscillation signal have a phase difference of 90° plus a variable phase correction factor that varies in response to the output signal of the mismatch estimation unit.

19. The direct conversion receiver of claim 17, wherein the phase of the second local oscillation signal and the first local oscillation signal have a phase difference of 90°, and the phase mismatch of the poly-phase filter varies in response to the output signal of the mismatch estimation unit.

20. The direct conversion receiver of any one of claims 18 and 19, wherein the mismatch estimation unit comprises:

a first adder that adds the output signal of the first mixer and an output signal of the second mixer;

a third mixer that mixes a signal output by the first adder with a third local oscillation signal;

a fourth mixer that mixes a signal output by the first adder, with a fourth local oscillation signal;

first and second square units which square output signals of the third mixer and the fourth mixer, respectively; and

a second adder that adds output signals of the first and second square units.

21. The direct conversion receiver of any one of claims 18 and 19, wherein the mismatch estimation unit comprises:

a phase shifter that generates a first output signal and a second output signal having a phase difference of 90°, from a signal obtained by adding output signals of the first mixer and the second mixer;

first and second square units which square the first output signal and the second output signal, respectively; and

a mismatch estimation unit adder that adds output signals of the first and second square units.

22. A direct conversion receiver (DCR) comprising:

a poly-phase filter that generates an in-phase differential signal and a quadrature-phase differential signal derived from a received radio frequency (RF) signal;

a differential signal adder that adds the in-phase differential signal and the quadrature-phase differential signal, and generates an added differential signal;

a differential signal subtracter that subtracts the quadrature-phase differential signal from the in-phase differential signal, and generates a subtracted differential signal;

a mixer unit that mixes the added differential signal with a first local oscillation signal and mixes the subtracted differential signal with a second local oscillation signal; and

a mismatch estimation unit that estimates a DCR gain mismatch from the output signals of the mixer unit, for adjusting the gain mismatch of at least one of the poly-phase filter and the mixer unit in response to an output signal of the mismatch estimation unit.

23. The direct conversion receiver of claim 22, wherein the mixer unit comprises:

a first mixer which mixes the added differential signal with the first local oscillation signal; and

a second mixer which mixes the subtracted differential signal with the second local oscillation signal.

24. The direct conversion receiver of claim 23, wherein the mixer unit further comprises:

a variable gain adjuster for adjusting the gain of a signal output from the first mixer relative to the gain of a signal output from the second mixer.

25. The direct conversion receiver of claim 23, wherein the gain mismatch of the poly-phase filter varies in response to the output signal of the mismatch estimation unit.

26. The direct conversion receiver of any one of claims 24 and 25, wherein the mismatch estimation unit comprises:

a third mixer which mixes a signal obtained by adding an output signal of the first mixer and an output signal of the second mixer, with a third local oscillation signal;

a fourth mixer which mixes a signal obtained by adding the output signal of the first mixer and the output signal of the second mixer, with a fourth local oscillation signal;

square units which square output signals of the third mixer and the fourth mixer, respectively; and

a mismatch estimation unit adder that adds output signals of the square units.

27. The direct conversion receiver of any one of claims 24 and 25, wherein the mismatch estimation unit comprises:

a phase-shifting signal splitter that generates a first output signal and a second output signal having a phase difference of 90°, derived from a signal obtained by adding output signals of the first mixer and the second mixer;

square units which square the first output signal and the second output signal, respectively; and

a mismatch estimation unit adder that adds output signals of the square units, wherein the gain of the variable gain adjuster or the gain mismatch of the poly-phase filter varies so that a value that is obtained by low pass filtering an output of the mismatch estimation unit adder is minimized.

28. An apparatus comprising:

a poly-phase filter that generates an in-phase differential signal and a quadrature-phase differential signal, having a phase mismatch and/or a gain mismatch;

an first mixer which mixes the in-phase differential signal with a first local oscillation signal,

a second mixer which mixes the quadrature-phase differential signal with a second local oscillation signal; and at least one of:

a phase shifter, that phase shifts the first local oscillation signal by 90° plus the value of a variable phase calibration factor that calibrates for the phase mismatch of the poly-phase filter, and outputs the result as the second local oscillation signal; and/or

a variable gain adjuster for adjusting the gain of the signal output from at least one of the first mixer and the second mixer for calibrating for the gain mismatch of the poly-phase filter.